

Two newly recorded species of *Indigofera* (Fabaceae) in China

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Abstract This paper reports two newly recorded species from China, namely *Indigofera caloneura* with 1-foliolate leaves from Yunnan and *I. cordifolia* with simple leaves from Guangdong. There are another three species with simple leaves of *Indigofera* in China. Based on the microscopic observation of specimens, morphological characters which include habit, stem, leaf shape and size, indumentum, stipule and stipel, raceme, corolla color, standard shape and indumentum, anther, pod shape and size, and seed number per pod etc. in the five species are described and compared among one another. The five most important characters are chosen to discuss for taxonomic treatment.

Key words *Indigofera*, *Indigofera caloneura*, *Indigofera cordifolia*, Fabaceae, new record, Guangdong, Yunnan, China.

The genus *Indigofera* L. of the legume family (Fabaceae) is widely distributed in tropical and subtropical regions. In the most recent treatment 81 species are distributed in China (Fang & Zheng, 1994), of which three have simple or 1-foliolate leaves. For Southeast Asia there are totally eight species with simple or 1-foliolate leaves recorded, namely *I. brunoniana* Grah. ex Wall., *I. caloneura* Kurz, *I. cordifolia* Heyne ex Roth., *I. linifolia* (L. f.) Retz., *I. maymyoensis* Sanjappa, *I. minbuensis* Gage, *I. nummularifolia* (L.) Livera ex Alston, and *I. squalida* Prain (de Kort & Thijssse, 1984; Sanjappa, 1985). Among them, *I. linifolia*, *I. nummularifolia*, and *I. squalida* have been reported in China before (Fang & Zheng, 1994). When studying this genus for Flora of China, a specimen from Xishuangbanna of Yunnan and two additional ones from Guangdong with simple leaves or 1-foliolate leaves are found belonging to *I. caloneura* and *I. cordifolia* respectively. These two species have not been recorded in China before. In order to easily distinguish these species, morphological characters in habit, stem, leaf size and shape, leaf glands, indumentum, petiole, stipule, stipel, inflorescence length, flower size and hairs, and fruit shape are observed.

1 Material and methods

Morphological features are based on more than 50 herbarium specimens from CDBI, HITBC, IBSC, KUN, and PE. Microscopic characters were obtained by using stereo microscope (Zeiss Stemi 2000, Germany). Each species was represented by more than one specimens in the microscopic observations. The materials used for microscopic study are listed in Table 1.

2 Results and discussion

Main morphological characters observed are listed in Table 2. The five most important characters are discussed below.

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Table 1 Materials used for microscopic study and their voucher information

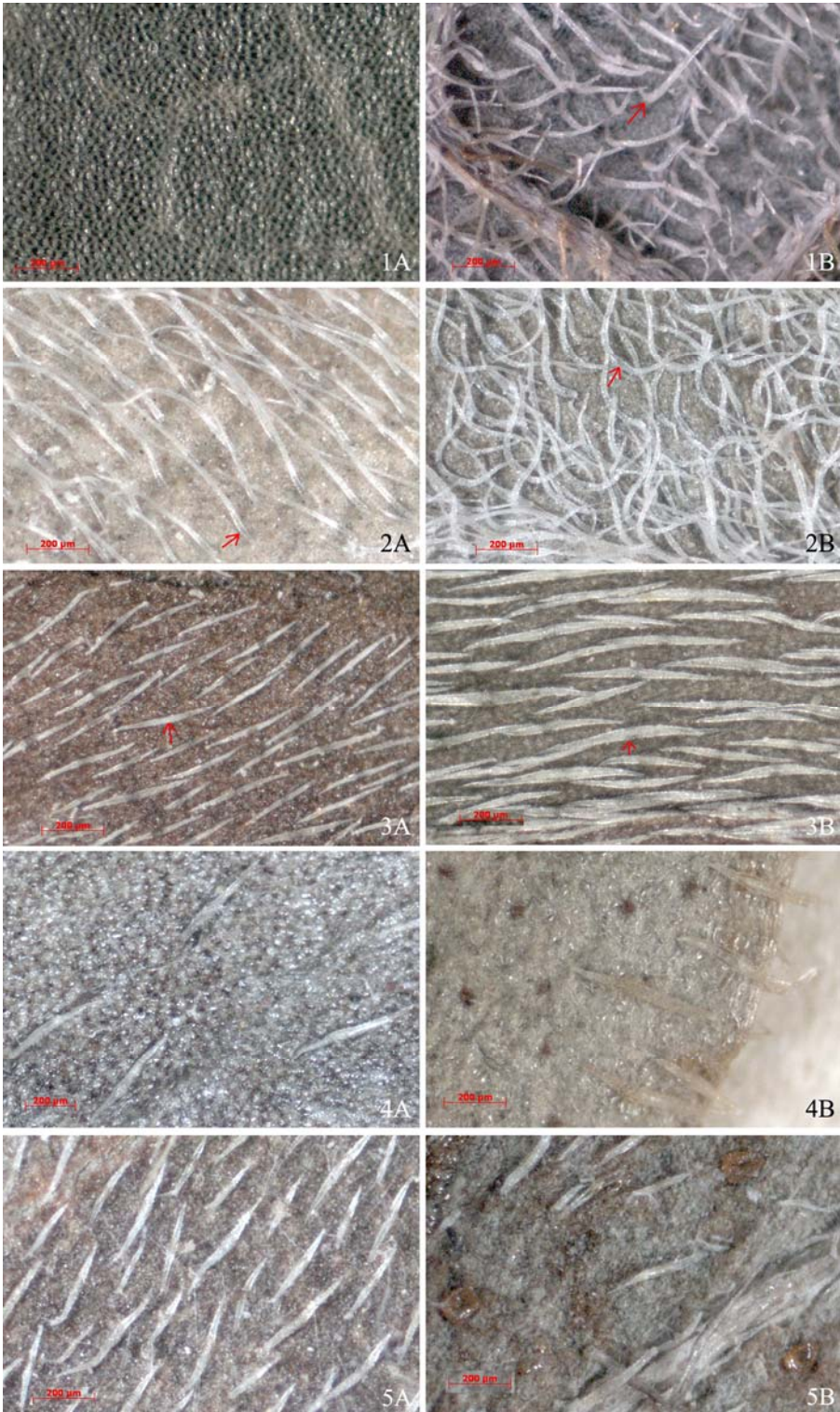
Species name	Locality	Voucher	Figure number
<i>Indigofera caloneura</i>	Mengla, Yunnan (云南勐腊)	Exp. Team (考察队) 35312	1A, 1B, 14
<i>I. cordifolia</i>	Lian Xian, Guangdong (广东连县)	Veget. Exp. (山地植被组) s.n.	2A, 2B, 6, 10, 15
<i>I. linifolia</i>	Huili, Sichuan (四川会理)	T. T. Yu (俞德浚) 1633	3A, 3B, 7, 11
<i>I. nummularifolia</i>	Ya Xian, Hainan (海南崖县)	C. Huang (黄志) 34814	4A, 4B, 8
	Ya Xian, Hainan (海南崖县)	K. Z. Hou (侯宽昭) 73843	12
	Anlong, Guizhou (贵州安龙)	G. S. Liao (廖国胜) 1468	5A, 5B, 9
<i>I. squalida</i>	Menglian, Yunnan (云南孟连)	Menglian Exp. (孟连队) 9425	13

Table 2 Main morphological characters of *Indigofera* species with simple and 1-foliolate leaves in China

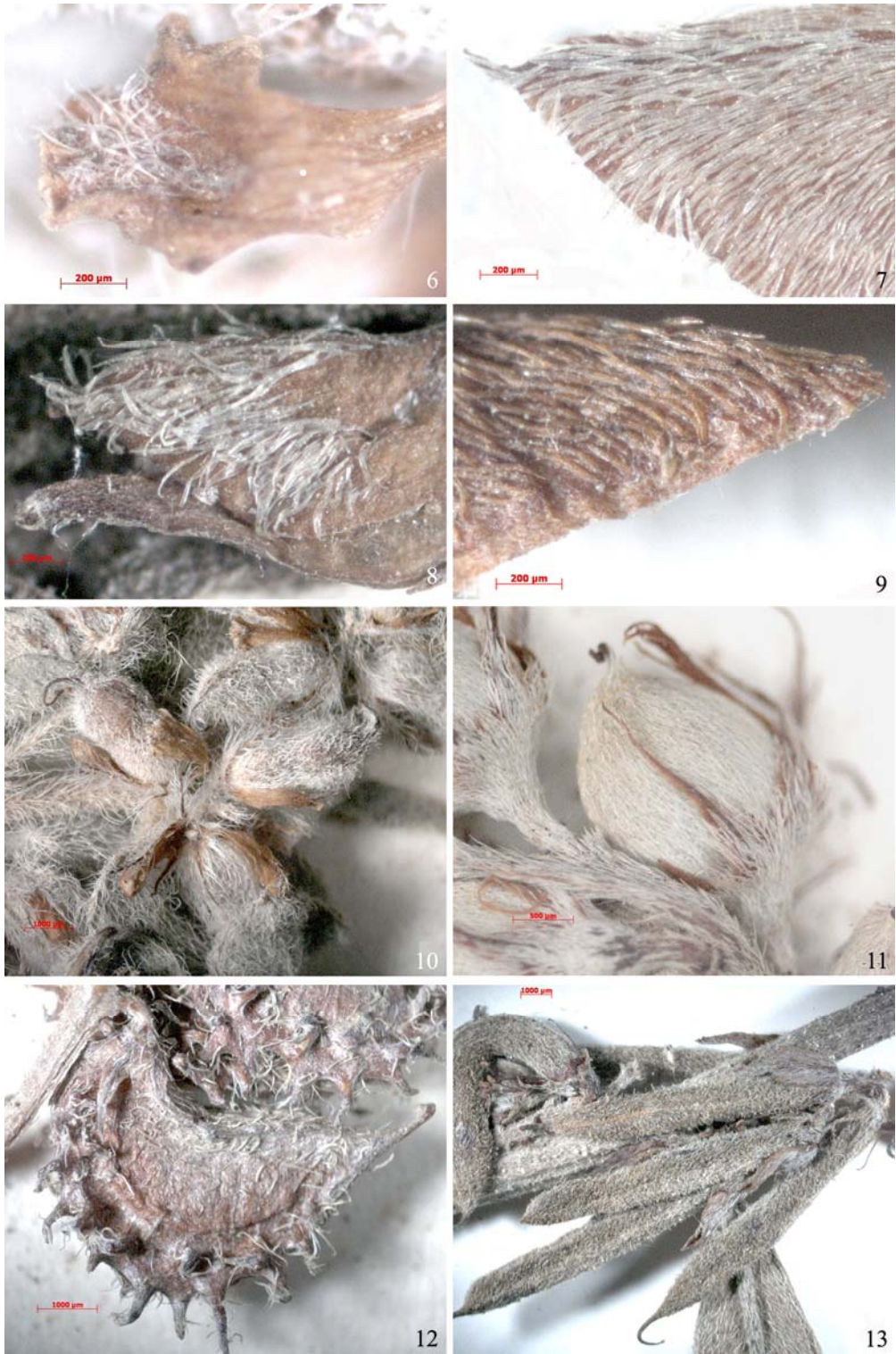
Characters	<i>I. caloneura</i>	<i>I. cordifolia</i>	<i>I. linifolia</i>	<i>I. nummularifolia</i>	<i>I. squalida</i>
Root	straight	straight	straight	straight	tuberous
Habit	shrub	perennial herb	shrublet or herb	perennial herb	perennial herb
Stem	erect	procumbent	erect or prostrate	prostrate	erect
Leaf size (mm)	80–100×40–55	4–8×3–6	5–30×2–4	10–20×7–10	25–55×7–20
Leaf or leaflet shape	oblong or elliptic	cordate	linear, narrowly obovate or elliptic	obovate-elliptic or obovate	narrowly elliptic to obovate
Hair type	spreading sub-basifixed biramous	spreading subbasifixed to medifixed biramous	adpressed medifixed biramous	adpressed medifixed biramous	adpressed medifixed biramous
Glands on leaf beneath	absent	absent	absent	dotted	disc-shape
Lateral nerves (pairs)	15–20	invisible	invisible	3–5	10–11
Stipel (mm)	1.5–2	absent	absent	absent	absent
Racemes length (cm)	7–13, multi-flowers	0.2–0.3, 1–4-flowers	1–1.5, multi-flowers	1.5–2, multi-flowers	1–2, densely flowered
Flower colour	white or yellow brown to orange-yellow	bright red	red	red	red or purple
Flower length (mm)	6–10	2.5–3	4–5	3	4–5
Standard shape	orbicular	spathulate	elliptic	broadly ovate	elliptic
Standard hairs outside	densely, brown, medifixed	sparsely, on the apex part, white, sub-basifixed	densely, white, medifixed	sparsely, on the apex part, white, medifixed	densely, brown, medifixed
Keel hairs	margin ciliate, densely outside	margin ciliate	glabrous	margin ciliate	densely outside, medifixed
Anther hairs	at the base	glabrous	glabrous	glabrous	glabrous
Fruit shape	linearly cylindric	ellipsoid or subglobose	ovoid	falcate, echinate	linearly cylindric
Fruit size (mm)	20–50×2–2.5	4–5×1.5	2×1.5	7×4	11–14×1.5–2
Fruit hairs	adpressed, medifixed biramous hairs	spreading, white sub-basifixed biramous hairs	adpressed medifixed biramous hairs	sparse, with sub-basifixed hairs	densely medifixed biramous hairs
Seed number	8–11	1 or 2	1	1	3–5

(1) Habit. The five species with simple or 1-foliolate leaves are usually perennial herbs or small shrublets with erect or procumbent stem except for *I. caloneura* which is erect and tall shrub.

(2) Hairs. Hair morphology is an important identification character in this genus (de Kort & Thijssse, 1984; Schrire, 1995). Biramous hairs have different fixed points with from



Figs. 1–5. The leaf surfaces of *Indigofera*. 1. *I. caloneura*, biramous hairs with very unequally arms. 2. *I. cordifolia*. 3. *I. linifolia*, biramous hairs with equally arms. 4. *I. nummularifolia*, with brown dotted glands and biramous hairs vertically along the margin (B). 5. *I. squalida*, with disc-shaped glands (B) and medifixed hairs. A, upper surface; B, lower surface.



Figs. 6–9. The dorsal surfaces of standards in *Indigofera*. **6.** *I. cordifolia*. **7.** *I. linifolia*. **8.** *I. nummularifolia*. **9.** *I. squalida*. **Figs. 10–13.** Pods of *Indigofera*. **10.** *I. cordifolia*. **11.** *I. linifolia*. **12.** *I. nummularifolia*. **13.** *I. squalida*.

equally to extremely unequally long arms on the two sides of the fixed point (Figs. 1B–5B). This feature has long been noticed and used as one of the main identification characters at specific level in the genus (de Kort & Thijssse, 1984; Sanjappa, 1995; Schrire, 1994). However, it was only rarely well-described in the past (Craib, 1913; de Kort & Thijssse, 1984; Fang & Zheng, 1994). For the species with simple or 1-foliolate leaves in China, hairs are either adpressed (Figs. 3A–5B) or spreading (Figs. 1B, 2B), and either sub-basifixed point with extremely unequally long arms (Figs. 1B, 2A) or medifixed point with more or less equally long arms (Figs. 2B–5B).

(3) Leaves. Leaf features (shape, size, and indumentum) are very different in the five species. *Indigofera caloneura* has large oblong or elliptic leaves with spreading sub-basifixed biramous hairs beneath (Fig. 1B) and glabrous above (Fig. 1A), *I. cordifolia* has small and cordate leaves with spreading biramous hairs sub-basifixed above (Fig. 2A) and sub-medifixed beneath (Fig. 2B), *I. linifolia* has linear or narrowly elliptic leaves with medifixed biramous hairs on both surfaces (Figs. 3A, 3B), *I. nummularifolia* leaves obovate with medifixed biramous hairs along the margin on both surfaces (Figs. 4A, 4B) and dotted glands beneath (Fig. 4B), and *I. squalida* leaves elliptic with sparsely medifixed biramous hairs on both surfaces (Figs. 5A, 5B) and disc-shape glands beneath (Fig. 5B).

(4) Corollas. Corolla morphology (color, size, shape, and indumentum) is valuable for species identification. Corollas are usually red to purple except for that in *I. caloneura* which is whitish, yellow-brown to orange-yellow. Standards have very different shapes. They are spatulate in *I. cordifolia*, elliptic in *I. linifolia* and *I. squalida*, orbicular in *I. caloneura*, and broadly ovate in *I. nummularifolia*. Standards are usually covered with different hairs. Those of *I. linifolia* and *I. squalida* are covered with adpressed biramous hairs with medifixed point on the dorsal surface (Figs. 7, 9), while those of *I. cordifolia* and *I. nummularifolia* have biramous hairs with sub-basifixed point only on the dorsal surface of the apex part (Figs. 6, 8). Wings are usually glabrous, sometimes with ciliate hairs. Keels only in *I. caloneura* and *I. squalida* are densely covered with hairs, but those in other species are glabrous or only with ciliate hairs.

(5) Fruits. Fruit shape is very different in the five species. Falcate pods are found in *I. nummularifolia* only (Fig. 12), while *I. linifolia* has globose pods (Fig. 11), *I. cordifolia* subglobose pods (Fig. 10), and *I. caloneura* and *I. squalida* linearly cylindrical pods (Figs. 13, 14). They are easy to be identified.

3 Taxonomical treatment

The five species with simple and 1-foliolate leaves in China and additional three species in Southeast Asia belong to different sections, are distinguished as follows:

1. Leaves with minute and dot-shaped glands beneath, medifixed biramous hairs vertically along margins on both surfaces (Fig. 4B); standard with sub-basifixed biramous hairs towards the apex outside (Fig. 8); pods falcate, echinated along dorsal suture (Fig. 12)..... **I. nummularifolia**
1. Leaves without glands or with disc-shaped glands beneath, medifixed biramous hairs not vertically along margins; pods linearly cylindric, globose or subglobose.
2. The main root tuberous; leaves obovate, with medifixed biramous hairs on both surfaces, and sometimes sparsely with disc-shaped glands on lower surface (Fig. 5B); pods straight, linearly cylindric (Fig. 13)..... **I. squalida**
2. The main root not tuberous; leaves linear, narrowly obovate-lanceolate or elliptic, oblong or cordate, without any glands; pods linearly cylindric, globose or subglobose.
3. Leaves linear, narrowly obovate-lanceolate, or narrowly elliptic, with adpressed medifixed biramous hairs on both surfaces (Fig. 3A, 3B); stipels absent.
4. Leaves 10–35 mm long..... **I. linifolia**
4. Leaves 40–80 mm long..... **I. minbuensis**

3. Leaves oblong or cordate; stipels present or absent.
5. Stipels absent; leaves cordate, with spreading sub-basifixed biramous hairs above and sub-basifixed to medifixed biramous hairs beneath; flower 2.5–3 mm long; fruit elliptic or subglobose; seeds 2 per fruit..... ***I. cordifolia***
5. Stipels present; leaflets oblong or elliptic, with sub-basifixed biramous hairs; seeds numerous.
6. Leaf glabrous above, biramous stipules 3–5 mm long.
7. Leaf with adpressed medifixed biramous hairs on lower surface; petioles 2–3 cm long; flowers sparse in racemes which are shorter than leaves ***I. maymyensis***
7. Leaf with spreading sub-basifixed biramous hairs on the lower surface; petioles 0.7–1 cm long; flowers compact in racemes which are longer than leaves..... ***I. caloneura***
6. Leaf with adpressed medifixed biramous hairs on both surfaces; stipules 1 mm long; wings short-ciliate; keels ciliate and with hairs on dorsal surface of apex ***I. brunoniana***

The two new records are described here in detail.

1. *Indigofera caloneura* Kurz in J. Asiat. Soc. Bengal 42: 229. 1873; et in Fl. Brit. Burm. 1: 360. 1877; Baker in Hook. f., Fl. Brit. Ind. 2: 93. 1876; de Kort & Thijssse in Blumea 30: 112. 1984; Sanjappa in Reinwardtia 10 (2): 218. 1985. Type: Burma. Pegu, *Kurz s.n.* (CAL).

I. oblonga Craib in Kew Bull. 6. 1914; Gagnep., Fl. Gen. Indo-Chine. 2: 440, 1916.

美脉木蓝 新拟 Figs. 1A, 1B, 14

[Sect. *Indigofera*] Erect shrubs; branches angular, densely adpressed brown sub-basifixed biramous hairs. Stipules narrowly triangular, 4–5 mm long. Petioles 10–15 mm long. 1-foliolate, lamina 8–10 cm long and 4–5.5 cm broad, oblong or elliptic, obtuse or rounded at base and apex; dark green and glabrous above; spreading gray or brown sub-basifixed biramous hairs on lower surface; secondary nerves pinnate, 15–17 pairs; stipels 2, linearly subulate, 1.5–2 mm long. Racemes 7–13 cm long, compactly many-flowered; bracts 3.5–4



Fig. 14. Specimens of *Indigofera caloneura*.



Fig. 15. Specimens of *Indigofera cordifolia*.

mm long, setaceous, deciduous; pedicels 1–1.5 mm long, 3–5 mm long in fruiting, densely tomentose. Flowers pink, 8–10 mm long; calyx 2–2.5 mm long, tube short, teeth triangular, acute; standard 8–10 mm long, ovate, obtuse and mucronulate at apex, adpressed densely brown pubescent on the dorsal surface; wings 6–8 mm long, ciliate; keels 7–9 mm long, with thickly brown pubescent on dorsal surface; anthers with hairs at the base; ovary glabrous. Pod straight, cylindrical, 4–5.3 cm long, spreading, adpressed minute hairs, endocarp red-spotted. Seeds 8–11, dark brown. Fl. May–Aug. Fr. Nov.–Jan.

China. S Yunnan (云南南部): Mengla (勐腊), 101°41' E, 21°37' N, alt. 900 m, 1983-12-07, *Exped. Team* (考察队) 35312 (HITBC!).

Myanmar. Shan hills, *C. B. Collett* 706 (K!); *Geo. B. Vogt. BU-443*, (K!); Amherst, J. H. Lacc 5668 (K!).

Thailand. Doi Nang Keo, *Kerr* 2524 (BM!, K!); Pahem Park, *Kerr* 5171 (BM!, K!); Doi Chiengdao, *Kerr* 4457 (BM!); Bo laung, *K. Larsen et al.* 1912 (K!).

Distribution: S. China, Laos, Myanmar, Thailand, and Vietnam.

2. *Indigofera cordifolia* Heyne ex Roth, Nov. Plant. Sp. Ind. Orient. 357. 1821; Baker in Hook., Fl. Brit. Ind. 2: 93. 1876; Ali in Bot. Not. 3: 545. 1958; de Kort & Thijssse in Blumea 30: 116. 1984. Type: India. Or., *Heyne s.n.* (B)

心叶木蓝 新拟 Figs. 2A, 2B, 6, 10, 15

[Sect. *Brachycapae*] Herbs, 10–30 cm tall. Branches procumbent or ascending, adpressed to slightly spreading white sub-basifixed biramous hairs. Leaves simple, petiole 1 mm long; stipules lanceolate, spreading sub-basifixed biramous hairs outside, 2 mm long, apex cuspidate; lamina 4–8×3–6 mm, cordate, apex acute, mucro 0.2 mm long; spreading white sub-basifixed biramous long hairs on upper surface, densely spreading sub-medifixed biramous long hairs on lower surface; lateral nerves invisible. Racemes 2–3 mm long with 1–4 flowers in the leaf axils; bracts narrowly triangular, 2×0.5 mm, apex cuspidate; pedicels 0.5 mm long or sessile. Calyx with densely spreading white sub-basifixed long hairs, tube 0.5 mm long, teeth linear-triangular, 1.5–2 mm long; standard spatulate or cuneate, 2.5–3×1–1.5 mm, hairy on dorsal surface of apex, apex obtuse; wings 2.5×0.2 mm, glabrous; keels 2.5×0.5 mm, glabrous, lateral spur 0.25 mm long; Anthers 0.2×0.25 mm, glabrous; ovary spreading white long hairy; ovules usually 2, rarely 1. Pod ellipsoid or subglobose, 2.5–3×1.6 mm, densely subspreading white sub-basifixed biramous long hairs. seeds 2 or 1, red brown. Fl. Jul. –Sept. Fr. Sept.–Nov.

China. Guangdong (广东): Lian Xian (连县), Xingzi Qu (星子区), Baitangchong (柏塘冲), alt. 160 m, 1984–10–20, *H. X. Ao* (敖惠修) 8401 (IBSC!), the same place, open slope and exposed hills, 1987–10–23, *Vegetation Team* (山地植被组) *s.n.* (IBSC!).

Distribution: S. China, India, Java, Pakistan, Roti, Sawu, Sumba, Timor, Tropical Africa, and N. Australia.

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中国木蓝属两个分布新记录

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摘要 报道并描述了采自云南南部西双版纳具有1小叶的新分布种美脉木蓝*Indigofera caloneura* Kurz和采自广东具有单叶的新分布种心叶木蓝*I. cordifolia* Heyne ex Roth。在中国还有另外3个具有单叶的种类, 即单叶木蓝*I. linifolia*、刺莢木蓝*I. nummularifolia*和远志木蓝*I. squalida*。通过从植物习性、茎、叶的形态与大小及毛被、托叶、花序、花冠形状与毛被、花药、子房毛被、果实的形态与大小、所含种子数目等特征的显微观察, 比较了国产单叶类木蓝属*Indigofera*植物的形态学特征差异, 并针对茎、叶、毛被、花冠旗瓣和果实形状等5个最重要的特征进行了讨论。

关键词 木蓝属; 美脉木蓝; 心叶木蓝; 豆科; 新记录; 广东; 云南; 中国